Depression, Anxiety, and Smoking Initiation: A Prospective Study Over 3 Years

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ABSTRACT

Objectives. This report considers the extent to which depression and anxiety predict smoking onset in adolescence.

Methods. A 6-wave cohort design was used to study a sample of 14- and 15-year-old students (n = 2032) drawn from 44 secondary schools in the state of Victoria, Australia. The students were surveyed between 1992 and 1995 with a computerized questionnaire that included a 7-day retrospective diary for tobacco use and a structured psychiatric interview.

Results. Experimental smokers were 29 times more likely than non-smokers to make a transition into daily use in the subsequent 6 months. Depression and anxiety, along with peer smoking, predicted initiation of experimental smoking. Specifically, depression and anxiety accentuated risks associated with peer smoking and predicted experimentation only in the presence of peer smoking.

Conclusions. The finding that experimental smoking is an overwhelmingly strong predictor of later daily smoking focuses attention on smoking initiation. Depressive and anxiety symptoms are associated with higher risks for initiation through an increased susceptibility to peer smoking influences. Promoting the psychological well-being of adolescents and addressing perceived interpersonal benefits of smoking may play a role in the prevention of adolescent tobacco use. (*Am J Public Health.* 1998;88:1518–1522)

There are reasons to consider further the relationship between depression and anxiety and smoking initiation.[1] Depressive symptoms are common in established smokers and predictive of persisting tobacco use.[2,3] Retrospective reports from adult smokers and cross-sectional studies in adolescent smokers suggest that the association with depression is established early.[4–8] One study's observation that depression in non-smoking 15-year-olds predicted smoking 10 years later provides further evidence of the significance of this association.[9]

As yet, the basis of the association between depression and early smoking is uncertain. Cross-sectional similarities between teenage ex-smokers and smokers suggest that, rather than being a consequence of smoking, depression may influence the uptake or course of adolescent smoking.[5] Self-medication of depressive symptoms, raising risks of progression to habitual use, is one plausible explanation.[10,11] Alternatively, depressive symptoms may leave an adolescent more vulnerable to peer smoking influences, in which case depression and anxiety might be expected to accentuate peer influences on the onset and progression of tobacco use.[12] There also remains a possibility that smoking and psychiatric morbidity have common origins in either genetic or environmental influences.[13] This paper considers the association between depression and anxiety and smoking uptake using data from a prospective 6-wave study of a population-based sample of adolescents.

Methods

Procedures and Sample

Data were collected between August 1992 and July 1995 in a statewide cohort study of adolescent health conducted in Victoria, Australia. This state has a population of 4.4 million, of whom 63% live in the capital city of Melbourne.[14] The study sample was defined in an initial cross-sectional survey via a 2-stage procedure. At stage 1, 45 schools were selected from a stratified frame of government, Catholic, and independent schools with a probability proportional to the number of year 9 students (14- and 15-year-olds) in the schools in each stratum in the state (total number: 60 905). At stage 2, a single intact class was selected at random to constitute the wave 1 sample. At the second wave of data collection 6 months later, when the study population had moved into year 10, a second intact class from each participating school was selected at random. One school from the initial cross-sectional survey was unavailable for the cohort study, leaving a total sample of 44 schools (88 class groups). Of these schools, 24 were government, 11 were Catholic, and 9 were independent private schools.

The study, presented as dealing with important health issues for adolescents, addressed a range of health risk behaviors. Active consent for participation, including written parental permission, was sought at entry into the study. Participants completed the questionnaire at intervals of 6 months between year 9 and year 12 (6 waves). Twenty-eight laptop computers were used to administer the questionnaire to each class.[15] Participants unavailable for follow-up at

school were administered the questionnaire by telephone.

Measures

Tobacco consumption was detailed with a 7-day retrospective diary. As a means of reducing unnecessary questions, never smokers and self-defined ex-smokers who had not smoked a cigarette in the previous month did not complete the diary. Smoking was categorized on the basis of frequency. In order to define a group in which dependent smoking was more likely, reported smoking on 6 or 7 days of the previous week was classified as current daily smoking.[16] Reported smoking in the previous month was categorized as any current smoking. Self-defined ex-smokers who reported not having smoked in the month before the survey were classified as ex-smokers. Those reporting cessation in the 4 weeks before the survey were placed in the any current smoking category.

Mental health status was evaluated at each wave with a computerized form of the revised Clinical Interview Schedule, a structured interview designed to assess symptoms of anxiety and depression in nonclinical populations.[17,18] This scale generates scores (0 to 4) on 14 subscales of common psychiatric symptoms. These scores were summarized into a total score and grouped into 4 levels of psychiatric morbidity: level 1 (0 through 5), level 2 (6 through 11), level 3 (12 through 17), and level 4 ($\geq$18). This grouping incorporated a threshold of 12 or higher corresponding to a point at which a general practitioner might be concerned about an individual's mental health.[17,18]

Peer smoking at each wave was defined at 3 levels according to whether none, some, or most of a subject's friends were reported as smokers. Alcohol consumption was defined by means of a 7-day retrospective diary. Dieting was categorized at 3 levels via the 9-item Adolescent Dieting Scale.[19] Exercise frequency was categorized at 2 levels depending on whether a participant reported daily exercise. Demographic variables were assessed at entry into the study. Separate questions dealt with maternal and paternal smoking, and parental smoking was defined as at least one parent smoking daily.

Analysis

Data analysis was undertaken in the SAS[20] and Stata[21] programs. Prevalence estimates were weighted by the inverse sampling fraction in each geographic area to allow for chance undersampling in areas of the state. Stratum weights were less than 1.5 for all but 2 of the 10 geographic regions of Victoria (these 2 regions had weights of 2.0 and 2.2).

TABLE 1—Odds Ratios From Multiple Logistic Regression Analyses of Smoking at Study Entry Adjusted for Covariates in 1688 Secondary School Students With Multiple Waves of Data: Victoria, Australia, 1992–1995

	Adjusted Odds Ratio (95% Confidence Interval)	
	Any Smoking (n = 372)	Daily Smoking (n = 131)
Age, y	1.0 (0.8, 1.4)	1.3 (0.8, 2.0)
Sex (female)	1.0 (0.7, 1.4)	1.0 (0.6, 1.8)
Clinical Interview Schedule depression and anxiety score		
0–5	1.0 . . .	1.0 . . .
6–11	1.3 (0.9, 1.9)	1.2 (0.7, 2.2)
12–17	1.4 (0.9, 2.2)	1.2 (0.4, 3.7)
18+	2.0 (1.3, 2.9)	2.1 (1.1, 4.1)
Peer smoking		
No peers who smoke	1.0 . . .	1.0 . . .
Some peers who smoke	8.6 (4.9, 15)	14 (2.9, 68)
Most peers smoke	36 (20, 66)	110 (23, 524)
Dieting status		
Nondieter	1.0 . . .	1.0 . . .
Intermediate	0.8 (0.6, 1.1)	0.8 (0.5, 1.3)
Severe	0.4 (0.2, 0.9)	0.4 (0.1, 1.1)
Either parent a daily smoker[a]	1.2 (0.9, 1.7)	2.1 (1.5, 3.1)
High alcohol consumption[b]	5.0 (3.1, 8.2)	2.8 (1.3, 6.3)
Daily sports	0.6 (0.4, 0.8)	0.7 (0.4, 1.1)

[a]109 subjects had incomplete data.
[b]Defined as $\geq$14 units per week in boys and $\geq$7 units per week in girls.

Onset of smoking incidence rates were calculated by dividing the numbers of incident cases by total person-years at risk, the latter calculated via midpoints between relevant data waves. A binary outcome (commenced any smoking or commenced daily smoking) was defined for each at-risk time interval, and multivariable analysis of factors associated with incident smoking was performed with a discrete time version of the Cox proportional hazards model.[22] The model was fit through the "glm" command in Stata (with the complementary log–log link function) and included an offset term equal to the natural logarithm of the length of the time interval. Since the analysis included factors that varied with time (e.g., peer smoking status), each subject contributed several data points to the analysis, one for each wave of the study in which he or she was eligible for the transition in question and for which responses were provided for both the previous and current time points. Standard errors robust to potential nonindependence within subjects were obtained via the "information sandwich method."[23]

Results

Sample Characteristics

Of the total sample of 2032 students, 1947 (95.8%) completed the questionnaire at least once in the course of the study. Based on the total sample, response rates across waves were as follows: wave 1, 86.6%; wave 2, 85.0%; wave 3, 83.6%; wave 4, 80.2%; wave 5, 77.6%; and wave 6, 75.3%. The proportion of completed telephone interviews increased from 1% at wave 2 to 22% at wave 6. The gender ratio of the cohort (47.0% male) was similar to that in Victorian schools at the time of sampling.[24] Students' mean age at wave 1 was 14.5 years (SD = 0.5, range = 13.7 to 16.8), and the mean age at completion of the follow-up at wave 6 was 17.4 years (SD = 0.4). The 1688 (83%) participants with 2 consecutive waves of data at least once in the study are the principal focus of this report. Low completers (2 or fewer waves) differed in prevalence rates of daily smoking (odds ratio [OR] = 3.9, 95% confidence interval [CI] = 2.8, 5.6), but they did not report lower levels of smoking at the outset. These subjects did not differ in terms of high levels of depression and anxiety (Clinical Interview Schedule score of 12+) (OR = 1.2, 95% CI = 0.9, 1.6).

Cross-Sectional Associations With Smoking at Study Entry

At entry into the cohort, 422 of 1688 participants (weighted prevalence estimate = 25%, 95% CI = 23, 27) already fell into the category of any current smoking. One hundred fifty-one participants (weighted prevalence estimate = 9.7%, 95% CI = 8.1, 11.3) were daily smokers. Associations with any

smoking and daily smoking were examined in separate logistic regression analyses (Table 1).

Any smoking. The odds of smoking among those reporting most friends as smokers were 36 times greater than the odds among those reporting no peer smoking. High Clinical Interview Schedule scores and high-dose alcohol consumption carried independent associations with smoking. Daily participation in sports and extreme dieting were associated with lower smoking rates.

Daily smoking. The odds of daily smoking increased by a factor in excess of 100 among those who reported that most of their friends were smokers. Daily smoking was associated with high-dose alcohol consumption, daily parental smoking, and high psychiatric morbidity.

Predictors of Smoking Initiation

Just under 14% of nonsmokers became smokers for each study year of risk. Eight percent of eligible participants made a first transition into daily smoking for each study year of risk. Smoking initiation was examined in 2 separate multivariable analyses for any smoking and daily smoking, respectively (Table 2). The models included stable risk factors defined at the outset and time-varying risk factors defined at the wave prior to transition. All 2-way interactions were tested, but the only one found to be significant at $P < .1$ was that between peer smoking and psychiatric morbidity for transition into both experimental smoking (likelihood ratio test: $\chi^2_6 = 13.2$, $P = .04$) and regular smoking ($\chi^2_4 = 9.6$, $P = .05$). For this reason, associations with psychiatric morbidity were estimated separately for each level of peer smoking.

Any smoking. Depression and anxiety significantly predicted smoking onset in instances in which peer smoking was reported, with the clearest linear trend apparent in those reporting most of their friends to be smokers. Self-defined ex-smokers at study entry were 3 times more likely than never smokers to make a transition to any smoking.

Daily smoking. Smoking status at the previous wave was the strongest predictor of initiation of daily smoking. Smokers in the week prior to the survey were 29 times more likely than nonsmokers to make an incident transition to daily smoking. Depression and anxiety significantly predicted transition to daily smoking only in instances in which most of the student's friends were reported to be smokers. Parental smoking was a moderate independent predictor of incident daily smoking.

TABLE 2—Adjusted Hazard Ratios From Discrete Time Survival Models of Predictors of Adolescent Smoking Onset Based on 4435 Possible Transitions to Any Smoking and 5759 Possible Transitions to Daily Smoking

	Adjusted Hazard Ratio (95% Confidence Interval)	
	Any Smoking (n = 299)	Daily Smoking (n = 203)
Age, y	0.6 (0.5, 0.7)	0.9 (0.7, 1.1)
Sex (female)	1.0 (0.7, 1.3)	0.8 (0.5, 1.1)
Smoking status in previous wave		
Nonsmoker	1.0 . . .	1.0 . . .
Ex-smoker[a]	3.0 (2.2, 4.2)	4.3 (2.5, 7.4)
Smoked in last month		15 (9.5, 24)
Smoked 1–5 days in last week		29 (17, 49)
CIS score: no peers who smoke		
0–5	1.0 . . .	1.0 . . .
6–11	1.1 (0.6, 2.3)	1.5 (0.5, 4.0)
12–17	0.4 (0.1, 1.5)	0.4 (0.1, 2.0)
18+	0.9 (0.3, 2.7)	. . .[b]
CIS score: some peers who smoke		
0–5	1.9 (1.3, 2.8)	0.9 (0.5, 1.7)
6–11	2.5 (1.5, 4.0)	0.7 (0.3, 1.6)
12–17	3.2 (1.9, 5.5)	1.4 (0.7, 2.9)
18+	3.5 (2.0, 6.0)	. . .[b]
CIS score: most peers smoke		
0–5	1.9 (1.1, 3.5)	1.4 (0.7, 2.9)
6–11	1.7 (0.7, 4.0)	2.7 (1.3, 5.7)
12–17	3.1 (1.3, 7.6)	2.6 (1.3, 5.6)
18+	6.7 (3.4, 13)	. . .[b]
Dieting status		
Nondieter	1.0 . . .	1.0 . . .
Intermediate	1.2 (0.9, 1.5)	1.0 (0.7, 1.4)
Severe	0.6 (0.3, 1.2)	1.0 (0.5, 2.1)
Either parent a daily smoker	1.1 (0.9, 1.5)	1.6 (1.2, 2.1)
High alcohol consumption[c]	1.3 (0.8, 2.2)	1.2 (0.8, 1.8)
Daily sports	0.9 (0.6, 1.1)	1.0 (0.7, 1.5)

Note. CIS = revised Clinical Interview Schedule
[a]For transition into any smoking, ex-smoking was defined as instances in which a nonsmoker at the outset reported having smoked earlier in adolescence but not in the month prior to the first survey.
[b]For estimates of transition into regular smoking, the top 2 levels (12–17 and 18+) were combined to avoid low cell numbers.
[c]Defined as ≥14 units per week in boys and ≥7 units per week in girls. One unit is equivalent to 9 g of ethanol.

Peer Smoking, Psychiatric Morbidity, and Initiation of Smoking

As a means of examining possible differences between girls and boys in the initiation of smoking, the hypothesis that depression and anxiety increase one's vulnerability to peer smoking influences was examined in more detail in an analysis of high Clinical Interview Schedule scores (12+) and transition to any smoking stratified by sex and level of peer smoking reported at the previous wave (Table 3). Rates and rate ratios for transition in each category were estimated. As can be seen in Table 2, psychiatric morbidity carried no increased risk for smoking initiation in participants without smoking peers. For those who reported most peers to be smokers, high psychiatric morbidity increased that risk almost 3-fold. For those in the intermediate category of peer smoking,

psychiatric morbidity significantly increased the risk in girls but not in boys.

Past Smoking, Psychiatric Morbidity, and Initiation of Daily Smoking

The possibility that sex influences the effect of depression and anxiety on progression to a more dependent pattern of smoking was considered in a stratified analysis of the association of Clinical Interview Schedule status and incident daily smoking (Table 4). Boys in the high scoring category were more likely to make a transition to daily smoking, with the effect being most marked for current smokers and those in the nonsmoking category. Female nonsmokers in the high scoring category were also more likely to make a transition into daily smoking, but this association appeared to be absent in ex-smokers and those smoking at the previous wave.

TABLE 3—Rates of Initiation (per 1000 Person-Years of Risk) of Any Smoking Among Subjects Reporting High and Low Levels of Psychiatric Symptoms, by Sex and Levels of Peer Smoking 6 Months Earlier: Secondary School Students, Victoria, Australia, 1992–1995

	Boys (1099 Person-Years of Observation)			Girls (1199 Person-Years of Observation)		
	Low CIS Score Rate (95% CI)	High CIS Score,[a] Rate (95% CI)	Rate Ratio (95% CI)	Low CIS Score, Rate (95% CI)	High CIS Score,[a] Rate (95% CI)	Rate Ratio (95% CI)
Peers nonsmokers	72 (48, 108)	108 (41, 288)	1.5 (0.5, 4.3)	86 (60, 125)	60 (23, 160)	0.7 (0.2, 2.0)
Some peers smokers	173 (140, 214)	204 (116, 360)	1.2 (0.6, 2.2)	145 (114, 184)	298 (221, 401)	2.1 (1.4, 3.0)
Most peers smokers	171 (100, 295)	445 (212, 933)	2.6 (1.0, 6.5)	186 (117, 296)	469 (305, 719)	2.5 (1.3, 4.7)

Note. CIS = revised Clinical Interview Schedule; CI = confidence interval.
[a]Score of 12+.

TABLE 4—Rates of Initiation (per 1000 Person-Years of Risk) of Daily Smoking Among Subjects Reporting High and Low Levels of Psychiatric Symptoms, by Sex and Level of Smoking 6 Months Earlier: Secondary School Students, Victoria, Australia, 1992–1995

	Boys (1426 Person-Years of Observation)			Girls (1626 Person-Years of Observation)		
	Low CIS Score Rate (95% CI)	High CIS Score,[a] Rate (95% CI)	Rate Ratio (95% CI)	Low CIS Score, Rate (95% CI)	High CIS Score,[a] Rate (95% CI)	Rate Ratio (95% CI)
Never smokers	32 (22, 45)	80 (43, 149)	2.6 (1.2, 5.6)	15 (9, 26)	33 (18, 62)	2.2 (1.0, 4.8)
Ex-smokers	326 (238, 447)	489 (263, 909)	1.5 (0.7, 3.0)	238 (163, 347)	228 (140, 372)	1.0(0.5, 1.8)
Current smokers	265 (138, 509)	1084 (451, 2605)[b]	4.1 (1.3, 12)	825 (577, 1180)[b]	875 (582, 1317)[b]	1.1 (0.6, 1.8)

Note. CIS = revised Clinical Interview Schedule; CI = confidence interval.
[a]Score of 12+.
[b]A rate greater than 1000/1000 person-years implies that most individuals make transitions in less than 1 year (more than half in the 6-month interval between waves).

Smoking Initiation as a Predictor of Depression and Anxiety

The possibility that smoking predicts future mental health was considered by analyzing transitions into high Clinical Interview Schedule status (scores of 12+). After adjustment for previous Clinical Interview Schedule score, neither incident transitions to any smoking (hazard ratio = 1.2, 95% CI = 0.7, 2.1) nor transitions to daily smoking (hazard ratio = 1.6, 95% CI = 0.9, 2.9) significantly predicted subsequent transition to high Clinical Interview Schedule status.

Discussion

This study's prospective multiwave design provides a clearer risk profile for smoking initiation than that derived from earlier cross-sectional studies. Experimental smoking was a very strong predictor of subsequent daily use, a finding that supports a focus on early experimentation in studies of risk and preventive intervention. In this context, both peer smoking and depression and anxiety were common and moderately strong predictors of smoking initiation. The persistence of the predictive relationship after control of potential confounders, including dieting, exercising, alcohol con-

sumption, and parental smoking, further strengthens the significance of a risk relationship between depression and anxiety and smoking. Although both the directionality and persistence of the association support a causal link, it remains possible that the association may reflect a common and unmeasured liability.

Earlier prospective studies with longer intervals (between 12 months and 4 years) provided much less scope for examining relationships between time-varying risk factors and adolescent smoking. In addition, although previous studies have included indirect measures of mental health status, few have used a detailed measure of depression and anxiety.[24] The present study has other strengths. Schools were drawn from a representative sample in the state of Victoria, Australia. Since school retention rates were 98% up to year 9 in the year of initial sampling, the sampling frame provided a nearly representative teenage study population.[25] Nevertheless, irregular participants differed on rates of daily smoking at first participation, and thus, despite high initial participation and low attrition in subsequent waves, there remains some possibility of misspecification of risk relationships. Specifically, the findings assume a similarity in the progression of smoking behavior of experimental smokers at outset who participated regularly

compared with the minority who did not.

The very high cross-sectional associations with peer smoking reported here are consistent with those of previous studies.[26] The disparity with the level of associations identified predictively may arise as a result of either differential affiliation with smoking peers after taking up smoking or the effect of peer smoking on subsequent quitting or smoking relapse.[27] Even so, peer smoking was predictive of smoking onset, an association accentuated when a subject reported high levels of psychiatric morbidity. The association with depression and anxiety was evident at a lower level of peer smoking in girls and may explain earlier findings that peer smoking influences are clearest in females.[28,29] The absence of association of smoking with high psychiatric morbidity among girls without smoking peers suggests that depression and anxiety might result in a more general tendency to adopt the behavioral norms of one's peer group. An explanation may be that symptoms such as social anxiety and loss of confidence result in a greater readiness to adopt the values, attitudes, and behaviors of one's peer group.

There was less consistent support for an effect of depression and anxiety on progression to daily use. In girls, depression and anxiety raised risks for the transition to daily smoking only in previous nonsmokers. In

boys, however, both smokers and nonsmokers with high depression and anxiety were more likely to move to daily smoking, raising the possibility that self-medication may be a relevant risk process in this group.

Smoking, more than other adolescent health risk behaviors, has a propensity to progress from experimental to regular use, a finding that calls for an emphasis on initiation in risk research and health promotion.[30] Peer smoking is supported as an important influence on smoking initiation, but its effects are magnified in the presence of depressive and anxiety symptoms. Health promotional programs might therefore do well to consider the role of strategies to promote adolescent psychological well-being in the prevention of smoking. □

Acknowledgments

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